

OF THE
MECHANICAL
CAUSES
OF
CHYMICAL
PRECIPITATION.

By the Honourable
ROBERT BOYLE Esq;
Fellow of the *R. Society.*

L O N D O N,
Printed by *E. Flesher*, for *R. Davis*
Bookseller in *Oxford.* 1675.

ALCOHOLIC

BEVERAGE

1

2

3

4

5

6

7

8

9

10



Advertisement.

T*Hough I shall not deny, that, in Grammatical strictness, Precipitation should be reckoned among Chymical Operations; not Qualities, yet I did not much scruple to insert the following Discourse among the Notes about Particular Qualities, because many, if not most, of the Phænomena, mentioned in the ensuing Essay, may be considered as depending, some of them, upon a power, that certain bodies have to cause Precipitation, and some upon such a Disposition to be struck down by others, as may, if men please, be called Precipitability. And so these differing Affections may with (at least) tolerable Congruity be referred to those that we have elsewhere stiled Chymical Qualities.*

• Advertisement.

*But though I hope, I may in these few Lines have said enough concerning the name given to these Attributes, yet perhaps it will be found in time, that the things themselves may deserve a larger Discourse than my little leasure would allow them. For that is not a causeless Intimation of the Importance of the Subject, wherewith I conclude the following Tract, since besides that many more Instances might have been particularly referred to the Heads treated of in the Insuing Essay, there are improper kinds of Precipitation (besides those mentioned in the former part of the Discourse) to which one may not incongruously refer diuers of the Phænomena of Nature, as well in the greater as in the lesser world, whereof either no Causes at all, or but improper ones are wont to be given. And besides the simple Spirits and Salts usually employed by Chymists, there are many compounded and decomposed bodies not only factitious but natural, (and some such as one would scarce suspect) that may in congruous Subjects produce
such*

Advertisement.

such Precipitations, as I speak of. And the Phenomena and Consequents of such operations may in divers cases prove conducive both to the Discovery of Physical Causes, and the Production of useful effects; though the particularizing of such Phenomena do rather belong to a History of Precipitations, than to such a Discourse as that which follows, wherein I proposed not so much to deliver the latent Mysteries, as to investigate the Mechanical Causes of Precipitation.

A 3

O F

(I)
OF THE
MECHANICAL
CAUSES
OF
CHYMICAL
PRECIPITATION.

CHAP. I.

BY Precipitation is here meant such an agitation or motion of a heterogeneous liquor, as in no long time makes the parts of it subside, and that usually in the form of a powder or other consistent body.

A 4

As

2 Of the Mechanical Causes

As, on many occasions, Chymists call the substance that is made to fall to the bottom of the liquor, the *Precipitate*; so for brevity sake we shall call the body that is put into the liquor to procure that subsiding, the *Precipitant*; as also that which is to be struck down, the *Precipitable substance or matter*, and the liquor wherein it swims before the separation, the *Menstruum* or *Solvent*.

When a hasty fall of a heterogeneous body is procured by a *Precipitant*, the Operation is called *Precipitation* in the proper or strict sense: But when the separation is made without any such addition, or the substance, separated from the fluid part of the liquor, instead of subsiding emerges, then the word is used in a more comprehensive, but less proper, acceptation.

As for the Causes of Precipitation the very name it self in its Chymical sense having been scarce heard of in the Peripatetic Schools, it is not to be expected, that they should have given

of Chymical Precipitation. 3

an account of the Reasons of the thing. And 'tis like, that those few *Aristotelians*, that have, by their converse with the laboratories or writings of Chymists, taken notice of this Operation, would, according to their custom on such occasions, have recourse for the explication of it to some secret sympathy or antipathy between the bodies whose action and reaction intervenes in this Operation.

But if this be the way proposed, of accounting for it, I shall quickly have occasion to say somewhat to it in considering the ways proposed by the Chymists, who were wont to refer Precipitation, *either*, as is most usual, to a sympathy betwixt the *Precipitating* body and the *Menstruum* which makes the Solvent run to the embraces of the *Precipitant*, and so let fall the particles of the body sustained before; *or* (with others) to a great antipathy or contrariety between the acid salt of the *Menstruum* and the fixed salt of the Oil, or solution of cal-

4 Of the Mechanical Causes

calcined Tartar, which is the most general and usual *Precipitant* they imploy.

But I see not, how either of these causes will either reach to all the *Phænomena* that have been exhibited, or give a true account even of some of those, to which it seems applicable. For first, in *Precipitations*, wherein what they call a *sympathy* between the liquors, is supposed to produce the effect, this admired sympathy does not (in my apprehension) evince such a mysterious occult Quality as is presumed, but rather consists in a greater congruity as to bigness, shape, motion and pores of the minute parts between the *Menstruum* and the *Precipitant*, than between the same Solvent and the body it kept before dissolved. And though this sympathy rightly explained may be allowed to have an interest in some such *Precipitations* as let fall the dissolved body in its pristine nature and form, and only reduced into minute powder; yet I find not, that in the generality

of Chymical Precipitation. 5

ality of Precipitations this Doctrine will hold ; For in some that we have made of Gold and Silver in proper Menstruums, after the subsiding matter had been well washed and dried, several Precipitates of Gold made, some with oil of Tartar, which abounds with a fixed salt, and is the usual Precipitant, and some with an Urinous Spirit, which works by Vertue of a salt highly fugitive or Volatile, I found the powder to exceed the weight of the Gold and Silver I had put to dissolve ; and the Eye it self sufficiently discovers such Precipitates not to be meer metalline powders, but Compositions, whose consisting, not (as hath been by some body suspected) of the combined Salts alone, but of the metalline parts also, may be strongly concluded not only from the ponderousness of divers of them in reference to their bulk, but also manifestly from the reduction of true malleable metals from several of them.

CHAP.

CHAP. II.

THE other *Chymical* way of explicating Precipitations may, in a right sence, be made use of by a Naturalist on some particular occasions. But I think it much too narrow and defective, as 'tis in a general way proposed, to be fit to be acquiesced in. For first 'tis plain, that 'tis not only Salt of Tartar and other fixed Alcalies that precipitate most bodies that are dissolved in acid Menstruums; as in making of *Aurum fulminans*, oil of Tartar precipitates the Gold out of *Aqua Regis*: But acid liquors themselves do on many occasions no less powerfully precipitate metals and other bodies out of one another. Thus spirit of Salt, (as I have often tried) precipitates Silver out of *Aqua fortis*: The corrosive Spirit of Nitre copiously precipitates that white powder whereof they make *Bezoardicum Minerale*: Spirit or
oil

of Chymical Precipitation. 7

oil of Sulphur made by a glass-bell precipitates Corals, Pearls, &c. dissolved in Spirit of Vinegar, as is known to many Chymists, who now use this *Oleum Sulphuris per Campanam*, to make the Magistery of Pearls, &c. for which vulgar Chymists imploy *Oleum Tartari per deliquium*.

I have sometimes made a *Menstruum*, wherein though there were both Acid and Alcalizate Salts; yet I did not find, that either acid Spirits or oil of Tartar, or even Spirit of Urine would precipitate the dissolved substances.

And I have observed, *both* that Salts of a contrary nature will precipitate bodies out of the same *Menstruum*, as not only Salt of Tartar, but Sea-salt being dissolved, will precipitate each other, and each of them apart will precipitate Silver out of *Aqua fortis*; and that even, where there is a confessed contrariety betwixt two liquors, it may be so ordered, that neither of them shall precipitate what

8 Of the Mechanical Causes

is dissolved by the other ; of which I shall have occasion to give ere long a remarkable instance.

But it will best appear, that the abovementioned Theories of the Peripateticks and Chymists are at least insufficient to solve the *Phænomena* (many of which were probably not known to most of them, and perhaps not weigh'd by any,) if we proceed to observe the *Mechanical* ways, by which Precipitations may be accounted for; whereof I shall at present propose some Number, and say somewhat of each of them apart; not that I think all of them to be equally important and comprehensive, or that I absolutely deny, that any one of them may be reduced to some of the other; but that I think, it may better elucidate the subject, to treat of them severally, when I shall have premised, that I would not thence infer, that though, for the most part, Nature does principally effect Precipitations by one or other of these ways, yet in divers cases she
may

of Chymical Precipitation. 9

may not imploy two or more of them about performing the operation.

To precipitate the Corpuscles of a metal out of a Menstruum, wherein being once thoroughly dissolved it would of it self continue in that state, the two general ways that the nature of the thing seems to suggest to him that considers it, are, *either* to add to the weight or bulk of the dissolved Corpuscles, and thereby render them unfit to accompany the particles of the Menstruum in their motions ; *or* to weaken the sustaining power of the Menstruum, and thereby disable it to keep the metalline particles swimming any longer: which falling of the deserted parts of the metal or other bodie, does oftentimes the more easily insue, because in many cases, when the sustaining particles of the Menstruum come to be too much weakned, that proves an occasion to the metalline Corpuscles, disturbed in the former motion that kept them separate, to make occurrences and coalitions among themselves,

10 Of the Mechanical Causes

selves, and their fall becomes the effect, though not equally so, of both ways of Precipitation; as on the other side, there are several occasions on which the same Precipitant, that brings the swimming particles of the metal to stick to one another, does likewise, by mortifying or disabling the saline Spirits or other parts of the solvent, weaken the sustaining power of that liquor.

CHAP. III.

TO descend now to the distinct Considerations about these two ways: The first of the most general Causes of Precipitation is such a Cohæſion procured by the Precipitant in the solution, as makes the compounded corpuscles, or at least the associated particles of the dissolved body, too heavy to be sustained, or too bulky to be kept in a state of fluidity by the liquor.

That

of Chymical Precipitation. 11

That in many Precipitations there is made a coalition betwixt the small parts of the Precipitant and those of the dissolved metal, or other body, and frequently also with the saline spirits of the Menstruum, may be easily shewn by the weight of the Precipitate, which though carefully washed and dried, often surpasses; and sometimes very considerably, that of your crude metal that was dissolved; of which we lately gave an instance in *Aurum fulminans* and precipitated Silver; & we may yet give a more conspicuous one, in that which Chymists call *Luna Cornea*: For, if having dissolved Silver in good *Aqua fortis*, you Precipitate it with the solution of Sea-salt in fair water, and from the very white Precipitate wash the loose adhering salts, the remaining powder, being dried and slowly melted, will look much less like a metalline body than like a piece of horn, whence also it takes its name; so considerable is

B the

12 Of the Mechanical Causes
the additament of the saline to the
metalline particles.

And that part of such additaments
is, retained, may not only be found
by weighing, but in divers cases
may be argued from what is obvious
to the Eye: as if you dissolve Mer-
cury in *Aqua fortis*, and into the phil-
trated solution drop spirit of Salt, or
salt-water, or an urinous spirit, as of
Sal Armoniac, you will have a very
white Precipitate; but if instead of
any of these, you drop in deliquated
salt of Tartar, your Precipitate will
be of a brick or orange colour.
From which experiment and some o-
thers I would gladly take a rise to
perswade Chymists and Physitians,
that 'tis not so indifferent, as those
seem to think who look on Precipi-
tation but as a kind of Comminution,
by what means the precipitation is
performed. For by reason of the
strict adhesion of divers saline par-
ticles of the precipitant and the sol-
vent, the precipitated body, not-
withstanding all the wonted abluti-
ons

of Chymical Precipitation. 13

ons, may have its qualities much diversified by those of the particles of the liquors, when these are fitted to stick very fast to it. Which last words I add, because, though that sometimes happens, yet it does not always, there being a greater difference than every body takes notice of between Precipitations; as you will be induced to think, if you precipitate the solution of Silver with Copper, with spirit of *Sal Armoniac*, with salt water, with oil of Tartar, with quick-silver, with crude Tartar and with Zink. And in the lately proposed Example, you will think it probable, that 'tis not all one, whether to dissolved Mercury or Silver, you imploy the subtile distilled Spirits of Salt, or the gross body, whether in a dry form, or barely dissolved in common water. And thus much of the Conduciveness of *weight* to the striking down the Corpuscles of a dissolved Body.

That also the *Bulk* of a body may very much contribute to make it

14 Of the Mechanical Causes

sink or swim in a liquor, appears by obvious instances. Thus Salt or Sugar, being put into water either in lumps or even in powder that is but gross, falls at first to the bottom, and lies there, notwithstanding the Air that may be intercepted between its parts or externally adhere to it. But when by the insinuating action of the water it is dissolved into minute particles, these are carried up and down with those of the liquor and subside not. The like happens, when a piece of silver is cast into *Aqua fortis*, and in many other cases.

On the other side I have several times observed, that some bodies that had long swam in a Menstruum, whilst their minute parts were kept from convening in it, did afterwards by the coalition of many of those particles into bodies of a visible bulk coagulate and subside, (though sometimes, to hinder the evaporation of the Menstruum, the vessels were kept stopt.) Of this I elsewhere mention divers examples ;
and

of Chymical Precipitation. 15

and particularly in urinous and animal spirits, well dephlegm'd, I have found, that after all had for a considerable time continued in the form of a perfect liquor, and as to sense homogeneous, store of solid corpuscles, convening together, settled at the bottom of the glasses in the form of saline Crystals. Having also long kept a very red solution of Sulphur first unlock'd, (as they speak) made with highly rectified spirit of urine, I observed, that at length the Sulphureous particles, making little concretions between themselves, totally subsided and left the liquor almost devoid of tincture. By which you may see, that 'twas not impertinent to mention (as I lately did) among the subordinate causes of Precipitation, the associating of the particles of a dissolved body with one another. Of which I elsewhere give a notable Example in the shining powder that I obtained from Gold dissolved in a peculiar Menstruum, without any Precipi-

16 Of the Mechanical Causes

tant, by the coalition of the metalline particles, to which a tract of time gave ⁺ opportunity to meet and adhere in a convenient manner.

If in what the Chymists call *Precipitate per se*, the Mercury be indeed brought to lose its fluidity, and become a powder without being compounded with any additional body, (which doubt I elsewhere state and discourse of) it will afford us a notable instance to prove, that the coalitions of particles into clusters of the self same matter will render them unfit for the motion requisite to fluidity. For in this odd precipitation by fire, wherein the same Menstruum is both the Liquor and the Precipitate, being not all made at once, the Corpuscles that first disclose themselves by their redness, are rejected by those of the Mercury that yet remains fluid, as unable to accompany them in the motions that belong to Mercury as such.

CHAP.

CHAP. IV.

BEfore I dismiss that way of Precipitating, that depends upon the unwieldiness which the Precipitant gives to the body it is to strike down, it may not be impertinent, especially in reference to the foregoing part of this Paper, to consider, that perhaps in divers cases the Corpuscles of a dissolved body may be made unfit to be any longer sustained in the Menstruum, though the Precipitant adds very little to their bulk, or at least much more to their specific weight than to it. For I have elsewhere shewn, that in divers solutions made of bodys by acid Menstruums, there are either generated or extricated many small Aerial particles; and it will be easily granted, that these may be small enough to be detained in the pores of the liquor and be invisible there, if we consider, what a multitude of aerial and formerly imperceptible bubbles

18 Of the Mechanical Causes

is afforded by common water in our Pneumatical Receivers, when the incumbent air that before pressed the liquor, is pump't out. And if the Corpuscles of the dissolved body have any little Cavities or pores fit to lodge Aerial particles, or have asperous surfaces, between whose prominent parts the generated air may conveniently lie; in such cases, I say, these Invisible bubbles may be lookt upon, as making with the solid Corpuscles they adhered to, little aggregates much lighter *in specie* than the Corpuscles themselves would be; and consequently if the Precipitant consist of particles of such a size and shape as are fit to expel these little bubbles, and lodge themselves in the cavities possessed by them before, there will be produced new aggregates composed of the Corpuscles of the dissolved body and the particles of the Precipitant; which aggregates though they do take up very little or perhaps not at all more room (taking that word in a popular sense) than those,

of Chymical Precipitation. 19

those, whereof the Aerial bubbles made a part, will yet be Specifically heavier than the former Aggregates were, and may thereby overcome the sustaining power of the Menstruum.

One thing more may be fit to be taken notice of before we pass on further, namely, that 'tis upon the score of the Specific gravity of a body, and not barely upon the action of the Precipitant, that an aggregate or a Convention of particles does rather fall to the bottom than rise to the top. For, though the Agents that procured the Coalition, make the cluster of particles become of a bulk too unwieldy to continue in the liquor as parts of it; yet if each of them be lighter *in specie* than an equal bulk of the Menstruum, or if they so convene as to intercept a sufficient number of little bubbles or aerial Corpuscles between them, and so become lighter than as much of the Menstruum as they take up the room of, they will not be precipitated
but

20 Of the Mechanical Causes

but emerge; as may be seen in the Preparation of those Magisteries of Vegetables, I elsewhere mention; where some deeply colour'd plants being made to tinge plentifully the Lixivium they are boyled in, are afterwards by the addition of Alum made to curdle, as it were, into coloured Concretions, which being (totally or in part) too big to swim as they did before they conven'd, and too light in comparison of the Menstruum to subside, emerge to the top and float there. An easier and neater Example to the same purpose I remember I shewed by dissolving Camphire in highly rectified spirit of Wine, 'till the solution was very strong. For though the Camphire, when put in Lumps into the spirit, sunk to the bottom of it; yet, when good store of water, (a liquor somewhat heavier in *Specie* than Camphire,) was poured upon the solution, the Camphire quickly concreted and returned to its own nature, and within a while emerged to the top of the mingled liquors and floated

of Chymical Precipitation. 21

floated there. These particulars I was willing to mention here, that I might give an instance or two of those precipitations, that I formerly spake of as improperly so called. And here I must not decline taking notice of a Phænomenon, that sometimes occurs in Precipitations, and at first sight may seem contrary to our Doctrine about them. For now and then it happens, that after some drops of the Precipitant have begun a Precipitation at the top or bottom of the Solvent, one shakes the vessel, that the Precipitant may be the sooner diffused through the other liquor, but then they are quickly surprized to find, that instead of hastning the compleat Precipitation, the matter already precipitated disappears, and the solvent returns to be clear, or, as to sense, as uniform, as it was before the Precipitant was put into it. But this *Phænomenon* does not at all cross our Theory. For, when this happens, though that part of the Solvent, to which the Precipitant reaches, is disabled

22 Of the Mechanical Causes

disabled for Reasons mentioned in this Discourse to support the dissolved body, yet this quantity of the Precipitant is but small in proportion to the whole bulk of the solvent. And therefore, when the agitation of the vessel disperses the clusters of loosely concentered particles through the whole liquor, (which is seldom so exactly proportioned to the body it was to work on, as to be but just strong enough to dissolve it) that greater part of the Liquor, to which before the shaking of the vessel the Precipitant did not reach, may well be lookt upon as a fresh Menstruum, which is able to mortifie or overpower the small quantity of the Precipitant that is mingled with it, and so to destroy its late operation on the body dissolved, by which means the solution returns, as to sense, to its former state. Which may be illustrated by a not unpleasant Experiment, I remember I have long since made by precipitating a brick-coloured powder out of a strong solution of Sublimate

of Chymical Precipitation. 23

mate made in fair water. For this subsiding matter, being laid to dry in the Philter, by which 'twas separated from the water, would retain a deep but somewhat dirty colour; and if then, putting it into the bottom of a wine glass, I poured upon it, either clear oil of Vitriol, or some other strong acid Menstruum, the Alkalizat particles being disabled and swallowed up by some of the acid ones of the Menstruum, the other acid ones would so readily dissolve the residue of the powder, that in a trice the colour of it would disappear and the whole mixture be reduced into a clear Liquor, without any sediment at the bottom.

Thus much may suffice at present about the first general way of Precipitating Bodies out of the Liquors they swim in.

CHAP.

CHAP. V.

THE other of the two principal ways, by which Precipitations may be effected, is the disabling of the Solvent to sustain the dissolved body.

There may be many instances, wherein this second way of effecting Precipitations may be associated by Nature with the first way formerly proposed; but notwithstanding the cases, wherein Nature may (as I formerly noted) imploy both the ways therein, yet in most cases they sufficiently differ, in regard that in the former way the subsiding of the dissolved body is chiefly, if not only, caused by the additional weight as well as action of the external Precipitant; whereas in most of the instances of the later way, the effect is produced *either* without salt of Tartar, or any such Precipitant, *or* by some other quality of the Precipitant

of Chymical Precipitation. 25

tant *more than* by its weight, or at least *besides* the weight it adds: Though I forget not, that I lately gave an example of a shining powder of Gold, that fell to the bottom of a Menstruum without the help of an External Precipitant: But that was done so slowly, that it may be disputed, whether it were a true Precipitation; and I alledged it not as such, but to shew, that the increased bulk of Particles may make them unfit to swim in Menstruums, wherein they swam whilst they were more minute. And the like answer may be accommodated to the Precipitate *per se* newly mentioned.

This premised, I proceed now to observe, that the general way, I last proposed, contains in it several subordinate wayes, that are more particular; of which I shall now mention the chief that occur to me, and though but briefly, illustrate each of them by examples. And first a Precipitation may be made, if the saline or other dissolving particles of the
Menstru-

26 Of the Mechanical Causes

Menstruum are mortified or rendred unfit for their former function, by particles of a Precipitant that are of a contrary nature.

Thus Gold and some other minerals, being dissolved in *Aqua Regis*, will be precipitated with spirit of urine and other such liquors abounding with volatile and salino-sulphureous Corpuscles, upon whose account it is that they act; whence these salts themselves, though cast into a Menstruum in a dry form, will serve to make the like Precipitations. And I the rather on this occasion mention Urinous spirits than Salt of Tartar, because those volatile particles add much less of weight to the little Concretions, which compose the Precipitated powder.

Upon instances of this kind, many of the modern Chymists have built that Antipathy betwixt the Salts of the solvent and those of the Menstruum, to which they ascribe almost all Precipitations. But against this I have represented something already,
and

of Chymical Precipitation. 27

and shall partly now, and partly in the sequel of this discourse add some farther reasons of my not being satisfied with this Doctrine. For, besides that 'tis insufficient to reach many of the *Phænomena* of Precipitations, (as will ere long be shown,) and besides that 'tis not easie to make out, that there is any real antipathy betwixt inanimate bodies; I consider,

1. That some of those Menstruums, to which this Antipathy is attributed, do after a short commotion (whereby they are disposed to make convenient occurrences and coalitions) amicably unite into concretions participating of both the Ingredients; as I have somewhere shewn by an Example purposely devis'd to make this out; to do which I dropped a clear solution of fixed Nitre, instead of the usual one of common salt, upon a solution of silver, in *Aqua-fortis*: For the saline particles of the Solvent and those of the Precipitant, will, as I have elsewhere recited,

C

ted,

28 Of the Mechanical Causes

recited, for the most part friendly unite into such Crystals of Nitre for the main, as they were obtained from : And though this notion of the Chymists, if well explained, be applicable to far more instances than the proposers of it seemed to have thought on, and may be made good use of in Practice ; yet I take it to be such as is not true Universally, and, where it is true, ought to be explicated according to Mechanical Principles. For, if the particles of the Menstruum and those of the Precipitant be so framed, that upon the action of the one upon the other, there will be produced Corpuscles too big and unwieldy to continue in the state of fluidity, there will insue a Precipitation : But if the constitution of the corpuscles of the Precipitating and of the Dissolved body be such, that the Precipitant also it self is fit to be a Menstruum to dissolve that body in ; then, though there be an union of the Salts of the Precipitant

of Chymical Precipitation. 29

tant and the metal (or other *Solutum*) and perhaps of the solvent too, yet a Precipitation will not necessarily follow, though the saline particles of the two liquors seemed, by the heat and ebullition excited between them upon their meeting, to exercise a great and mutual antipathy. To satisfy some Ingenious men about this particular, I dissolved *Zink* or *Speltar* in a certain urinous spirit; (for, there are more than one that may serve the turn;) and then put to it a convenient quantity of a proper acid spirit; but though there would be a manifest conflict thereby occasioned betwixt the two liquors; yet the *Speltar* remained dissolved in the mixture. And I remember, that for the same purpose I devised another Experiment, which is somewhat more easie and more clear. I dissolved Copper calcined *per se*, or even crude, in strong spirit of salt; (for unless it be such, it will not be so proper,) and having put to it by degrees a

30 Of the Mechanical Causes

good quantity of spirit of Sal-Armoniac or fermented Urine, though there would be a great commotion with hissing and bubbles produced, the Copper would not be precipitated, because this Urinous spirit will as well as the Salt, (and much more readily) dissolve the same metal, and it would be kept dissolved notwithstanding their operation on one another; the intervening of which, and their action upon the metalline corpuscles, may be gathered from hence, that the green solution, made with spirit of salt alone, will by the supervening urinous spirits be changed either into a blewish green, or, if the proportion of this spirit be very great, into a rich blew almost like ultramarine. And from these two Experiments we may probably argue, that when the Precipitation of a metal &c. insues, it is not barely on the account of the supposed Antipathy betwixt the Salts, but because the causes of that seeming Antipathy do

of Chymical Precipitation. 31

do likewise upon a Mechanical account dispose the Corpuscles of the confounded liquors so to cohere, as to be too unwieldy for the fluid part.

CHAP. VI.

ANother way, whereby the dissolving particles of a Menstruum may be rendred unfit to sustain the dissolved body, is to present them another that they can more easily work on.

A notable Experiment of this you have in the common practice of *Refiners*, who, to recover the Silver out of *Lace* and other such mixtures wherein it *abounds*, use to dissolve it in *Aqua fortis*, and then in the solution leave Copper plates for a whole night (or many hours.) But if you have a mind to see the Experiment without waiting so long, you may

C 3

employ

32 Of the Mechanical Causes

employ the way, whereby I have often quickly dispatched it. As soon then as I have dissolved a convenient quantity, which needs not be a great one, of Silver in cleansed *Aqua fortis*, I add twenty or twenty five times as much of either distilled water or rain water; (for though common water will sometimes do well, yet it seldom does so well;) and then into the clear solution I hang by a string a clean piece of Copper, which will be presently covered with little shining plates almost like scales of fish, which one may easily shake off and make room for more. And this may illustrate what we formerly mentioned about the subsiding of metalline corpuscles, when they convene in liquors, wherein, whilst they were dispersed in very minute parts, they swam freely. For in this operation the little scales of Silver seemed to be purely metalline, and there is no saline Precipitant, as Salt of Tartar or of Urine, imployed to make them subside.

of Chymical Precipitation. 33

subside. Upon the same ground, Gold and Silver dissolved in their proper Menstruums may be precipitated with running Mercury ; and if a Solution of blew Vitriol (such as the Roman, East-Indian, or other of the like colours) be made in water, a clean plate of Steel or Iron being immersed in it, will presently be overlaid with a very thin case of Copper- which after a while will grow thicker ; but does not adhere to the iron so loosely as to be shaken off, as the Precipitated silver newly mentioned may be from the Copper-plates whereto it adheres. And that in these operations the saline particles may really quit the dissolved body, and work upon the Precipitant, may appear by the lately mentioned practice of *Refiners*, where the *Aqua-fortis*, that forsakes the particles of the silver, falls a working upon the copper-plates employed about the Precipitation, and dissolves so much of them as to acquire the greenish

34 Of the Mechanical Causes

blew colour of a good solution of that metal. And the Copper we can easily again without salts obtain by Precipitation out of that liquor with iron, and that too, remaining dissolved in its place, we can precipitate with the tasteless powder of another Mineral.

Besides these two ways of weakening the Menstruum, namely, by mortifying its saline particles or seducing them to work on other bodies, and to forsake those they first dissolved, there are some other ways of weakening the Menstruum.

A Third way of effecting this, is by lessening or disturbing the agitation of the solvent. And indeed since we find by experience, that some liquors when they are heated, will either dissolve some bodies they would not dissolve at all when they were cold, or dissolve them more powerfully or copiously when hot than cold; 'tis not unreasonable to suppose, that what considerably lessens

of Chymical Precipitation. 35

sens that agitation of the parts of the Menstruum that is necessary to the keeping the dissolved body in the state of fluidity, should occasion the falling of it again to the bottom. In slow operations I could give divers examples of the precipitating power of Cold; there being divers solutions and particularly that of Ambergreece, that I had kept fluid all the Summer, which in the Winter would subside. And the like may be sometimes observed in far less time in the solutions of Brimstone made in certain oleaginous Menstruums; and I have now & then had some solutions, and particularly one of *Benzoin* made in spirit of wine, that would surprize me with the turbidness (which begins the state of Precipitation) it would acquire upon a sudden change of the weather towards Cold, though it were not in the winter season.

Another way of weakening the Menstruum and so causing the Precipitation of a body dissolved in it, is the

36 Of the Mechanical Causes

the diluting or lessening the tenacity of it, whether that tenacity proceed from viscosity or the competent number and constipation of the parts.

Of this we have an instance in the Magisteries (as many Chymists are pleased to call them) of Jalap, Benzoin, and of divers others, Resinous and Gummous bodies dissolved in spirit of wine. For by the affusion of common water, the Menstruum being too much diluted is not able to keep those particles in the state of fluidity, but must suffer them to *subside*, (as they usually do in the form of white powder,) or, (as it may happen sometimes,) make some parts emerge. Examples also of this kind are afforded us by the common preparations of *Mercurius Vita*. For though in oil of Antimony, made by the Rectification of the butter, the saline particles are so numerous and keep so close to one another, that they are able to sustain the Antimonial

of Chymical Precipitation. 37

nial Corpuscles they carried over with them in Distillation, and keep them together with themselves in the form of a liquor; yet when by the copious affusion of the water, those sustaining particles are separated and removed to a distance from each other, the Antimonial Corpuscles and the Mercurial (if any such there were,) being of a ponderous nature, will easily subside into that Emetic powder, which, (when well washed) the Chymists flatteringly enough call *Mercurius Vita*.

But here I must interpose an advertisement, which will help to shew us, how much Precipitations depend upon the Mechanical contextures of bodies. For, though not only in the newly recited examples, but in divers others, the affusion of water, by diluting the salts and weakening the Menstruum, makes the metall or other dissolved body fall precipitately to the bottom; yet if the saline particles of the solvent, and those

38 Of the Mechanical Causes

those of the body be fitted for so strict an union, that the Corpuscles resulting from their Coalitions will not so easily be separated by the particles of water, as suffer themselves to be carried up and down with them, whether because of the minuteness of these compounded Corpuscles, or because of some congruity betwixt them and those of the water; they will not be precipitated out of the weakened solution, but still continue a part of it; as I have tryed partly with some solution of Silver and Gold, made in acid Menstruums, but much more satisfactorily in solutions of Copper, made in the urinous spirit of Sal Armoniac. For, though that blew solution were diluted with many thousand times as much distilled water as the dissolved metal weighed; yet its swimming Corpuscles did by their colour manifestly appear to be dispersed through the whole liquor.

CHAP.

CH A P. VII.

BUT, to prosecute our former discourse, which we broke off after the mention of *Mercurius Vite*, 'twill now be seasonable to add, that we have made divers other Precipitations, by the bare affusion of water, out of solutions, and sometimes out of distilled liquors; which, for brevity sake, I here omit, that I may hasten to the last way I shall now stay to mention.

Another way then, whereby Precipitations of bodies may be produced by debilitating the Menstruum they swim in, is by lessening the proportion of the Solvent to the *Solutum*, without any evaporation of the liquor. These last words I add, because that, when there is an obstruction or any other expulsion of the Menstruum by heat, if
it

41 Of the Mechanical Causes

it be total, 'tis called Exsiccation, as when dry salt of Tartar is obtained from the filtrated *Lixivium* of the calcined Tartar; and though the evaporation be not total, yet the effects of it are not wont to be reckoned amongst Precipitations. And although the way, I am about to propose, if it be attentively considered, has much affinity with the foregoing, and the *Phænomena* may perhaps in some sort be reduced to them; yet the instances that I shall name, having not, that I know, been thought of by others, and being such as every one would not deduce from what I have been mentioning, I shall add a word of the inducements I had to make the trials, as well as of the success of them.

Considering then, that Water will not dissolve Salts indefinitely, but when it has received its due proportion, 'twill then dissolve no more, but, if they be put into it, let them
fall

of Chymical Precipitation. 40

fall to the ground and continue undissolved; and that if when water is satiated, any of the liquor be evaporated or otherwise wasted, it will in proportion let fall the salt it had already taken up; I concluded, that if I could mingle with water any liquor, with which its particles would more readily associate than with those of Salt, the depriving the solution of so many of its aqueous particles would be equivalent to the evaporation of as much water or thereabouts, as they, by being united, could compose. Wherefore making a *lixivium* of distilled water or clean rain-water, and of Salt of Tartar so strong, that if a grain more were cast in it, it would lie undissolved at the bottom; I put a quantity of this fiery Lixivium into a slender cylindrical vessel, till it had therein reached such a height as I thought fit; then taking as much as I thought sufficient of strong spirit of wine, that
would

42 Of the Mechanical Causes

would burn every drop away, that so it might have no flegm nor water of its own, I poured this upon the saline solution, and shaking the liquors pretty well, together to bring them to mix as well as I could, I laid the tube in a quiet place, and afterwards found, as I expected, that there was a pretty quantity of white salt of Tartar fallen to the bottom of the vessel, which salt had been meerly forsaken by the aqueous particles that sustained it before, but forsook it to pass into the spirit of wine, wherewith they were more disposed to associate themselves; which I concluded, because having, before I poured on this last named liquor, made a mark on the glass to shew how far the *lixivium* reached, I found (what I looked for) that after the Precipitation, the *Lixivium*, that remained yet strong enough to continue unmixed with the incumbent spirit, had its surface not where the mark shewed it had been

4 pp misbound
at end of book

been before; but a considerable distance beneath it, the spirit of wine having gained in extent what it lost in strength by receiving so many aqueous particles into it. I chose to make this tryal rather with a *Lixivium* of Salt of Tartar than with oyl of Tartar *per Deliquium*, because in this last named liquor the aqueous and saline particles are more closely combined and therefore more difficult to be separated than I thought they would be in a *Lixivium* hastily made, though very strong. And though by much agitation I have sometimes obtained some salt of Tartar from the above-mentioned oil; yet the experiment succeeded nothing near so well with that liquor as with a *Lixivium*.

I made also the like tryal with exceedingly dephlegmed spirit of wine; and as strong a Brine as I could make of common salt dissolved without heat in common water; and I thereby obtained no despicable proportion of finely figured salt, that

D

was

These if
pp are new
pieces -

was let fall to the bottom. But this experiment, to be successful, requires greater care in him that makes it, than the former needs.

To confirm, and somewhat to vary this way of Precipitation, I shall add, that having made a clear solution of choice Gum Arabic in common water, and poured upon it a little high rectified spirit of wine, on this occasion there was also made, and that in a trice, a copious precipitation of a light and purely white substance not unpleasant to behold. And for further Confirmation I dissolved a full proportion of Myrrhein in fair water, and into the filtrated solution, which was transparent, but of a high brown colour, I dropt a large proportion (which Circumstance is not to be omitted) of carefully dephlegm'd spirit of wine, which according to expectation made a copious Precipitate of the Gum. And these instances I the rather set down in this place, because they seem to show, that
simple

Of Chymical Precipitation. 43
simple water is a real Menstruum,
which may have its dissolving and
sustaining virtue weakened by the
accession of Liquors, that are not
doubted to be much stronger than it.

By specifying the hitherto mentioned wayes, whereby Precipitations may be Mechanically performed and accounted for, I would by no means be thought to deny, that there may be some omitted here, which either others that shall consider the matter with more attention, or I my self, if I shall have leisure to do, it, may think on. For I propose these but as the chief that occur to my present thoughts; and I forbear to add more instances to exemplifie them, because I would not injure some of my other papers, that have a greater right to those Instances. Only this I shall note in general, that the Doctrin and History of Precipitations, if well delivered, will be a thing of more extent and moment than seems hitherto to have been imagined; since *not only* several of

the changes in the blood and other liquors and juices of the humane body may thereby be the better understood; and they prevented, or their ill consequences remedied; but in the practical part of Mineralogy divers usefull things may probably be performed by the assistance of such a Doctrine and History. To keep which conjecture from seeming extravagant, I shall only here intimate, that 'tis not alone in bodies that are naturally or permanently liquid; but in those solid and ponderous bodies, that are for a short time made so by the violence of the fire, that many of the things suggested by this Doctrine may have place. For whilst divers of those Bodies are in fusion, they may be treated as liquors; and metalls, and perhaps other heterogeneous bodies may be obtained from them by fit though dry Precipitants, as in some other writings I partly did, and may elsewhere yet further, declare.

FINIS.

